Experimental Study of Spatial Searching Behaviour of Travellers in Pedestrian Networks

Takamasa Iryo*

Hiroaki Shintaku

Shiho Senoo

Department of Civil Engineering,

Kobe University, Kobe, Japan

* Email: iryo@kobe-u.ac.jp

1 Introduction

It is important to investigate the mechanisms of a traveller's behaviour in pedestrian networks to propose appropriate plans for improving the attractiveness of destinations such as sightseeing areas, historical towns, shopping facilities, etc. One of the main problems in studying such behaviour is the complexity of a traveller's decision process. Unlike traditional assignment models that externally determine travellers' origins and destinations before route choices are made, travellers in pedestrian networks may not pre-determine their destinations before the start of the trip. Instead, the travellers may collect information while walking in a network to select destinations they will visit. Such behaviour is likely to be observed in areas whose information is not well known by travellers, and in general, travelling in an unfamiliar area is common when the purpose of the travel is enjoyment, such as sightseeing or shopping.

Several studies have investigated pedestrian behaviour in an unfamiliar network. Among these, one approach is a learning model to describe how people learn information on an area by repeatedly visiting that area (e.g. Arentze and Timmermans 2004, Arentze and Timmermans 2005). Another approach is the optimal stopping theory to describe how people select a destination in a network that they have not visited before (Iryo et al. 2009). In the latter model, a traveller first needs to search for destinations that seem attractive (i.e. having high utility) by walking in the network. Then, he/she stops searching and selects a destination when he/she feels that searching for more destinations will not pay off because the utility of a discovered destination is greater than the expected utility (including expected walking cost) that is to be gained by continuing searching. Once a traveller stops searching and selects a destination, other undiscovered destinations will never be known by him/her even if their utility is very high.

It is also known that actual behaviour of people may not be exactly the same as that expected by the optimal stopping theory. Bearden et al. (2006) carried out an experimental study on the so-called 'secretary problem', in which a decision maker sequentially interviews applicants for a secretary position; their results showed that the participants in the experiment tended to terminate their search too early. On the other hand, Iryo et al. (2009) carried out a similar experiment with different settings, and their results showed that participants tended to search for a longer duration than expected by the theory. These results imply that the actual behaviour of people may be different from that predicted theoretically and that the characteristics of such differences may depend on the settings of the problems.

This study aims to investigate the difference between the decisions predicted by the optimal stopping theory and those observed in controlled experimental environments. Two experiments were carried out for this purpose; one was carried out in computer-based simulated environments and the other was carried out in a real pedestrian network. Then, the results from both experiments were compared to estimate the mechanisms of traveller's decisions that have not been incorporated in the theoretical model.

2 Settings of the Experiments

Experiments were conducted both in a virtual space created in a personal computer and in a real pedestrian network of a sightseeing site. Both experiments considered a situation in which a traveller attempts to look for a destination such as a restaurant or café that he/she finds attractive. To control the conditions of the experiments, the following settings were employed:

- Participants in the experiments were asked to start from a given origin in the network, search destinations, select one of them, stay there, and return to the origin.
- Each destination, which was artificially assigned onto the network, was associated with a unique pre-assigned number corresponding to its utility; this number was known by a participant only when he/she stood in front of the destination.
- To let participants experience the utility of a destination, they were asked to spend a certain duration of time after selecting the destination. This duration was determined by the utility associated with the selected destination—if a participant selected a destination with lower utility, he/she was forced to waste a lot of time.

To prevent participants from learning information on destinations during the experiments, in the computer-based experiment, different networks were randomly prepared for each trial. In the real-world experiment, only one trial was carried out for each participant.

Data collected during the experiments were trajectories, destinations (and their utilities) discovered while walking, and the destination selected after searching. The movements of participants in the real world were recorded using GPS equipment. The choice set generated during searching (i.e. the set of discovered destinations), the selected destination, and average walking time for finding the next destination were collected to estimate how much the timing of decisions differed from that expected by the theory.

3 Results and Discussions

The results of the experiments indicate that the participants in both experiments tend to continue searching for longer than expected by the theory; that is, they tend to make 'excessive searches' after a sufficient amount of destinations have been discovered. These excessive searches can be explained by several reasons. One of these reasons is that people may enjoy searching something. This seems to be consistent with the result of the experiments because excessive searches are more prominent in the real-world network experiment than in the computer-based experiment. In addition, people may use their intelligence to plan effective searching routes that reduce searching cost, whereas this factor is not incorporated in the theoretical model. It is important to consider these factors to understand, for example, how to provide travellers with information on a pedestrian network or how to encourage people to look for more destinations in a network so that more facilities located deep within a network are discovered by more travellers.

References

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